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.. not available for a specific reference period
... not applicable
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0^s value rounded to 0 (zero) where there is a meaningful distinction between true zero and the value that was rounded
^{p} preliminary
^{r} revised
x suppressed to meet the confidentiality requirements of the *Statistics Act*
^{E} use with caution
F too unreliable to be published
* significantly different from reference category ($p < 0.05$)

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Abstract

Background: Parents influence the physical activity and sedentary behaviour of their children. This analysis examines associations between parental role modeling and support and children's physical activity and sedentary behaviour.

Data and methods: The sample consists of 1,328 biological parent-child pairs from the first three cycles of the Canadian Health Measures Survey (2007 through 2013). Data on physical activity and sedentary behaviour were collected using a questionnaire and by accelerometer. Pearson correlation and linear regression analyses were completed to examine associations between parents' and children's measured physical activity and sedentary time and reported screen-based activities. Analyses were adjusted for variables indicating parental support and household lifestyle characteristics.

Results: Accelerometer-measured physical activity and sedentary time were correlated in all parent-child pairs. Parents' measured moderate-to-vigorous physical activity (MVPA) was associated with children's MVPA ($\beta = 0.28$, $p < 0.001$). For every 20-minute increase in a parent's MVPA, the child's MVPA increased by 5 to 10 minutes. Parents' measured sedentary time was associated with that of their daughters on weekends, and with that of their sons during the after-school period. Parents' reported screen time was associated with that of their daughters.

Interpretation: This study confirms parents' influence on their children's physical activity. Parental role modeling and support have independent effects on a child's level of physical activity.

Keywords: Accelerometer, exercise health measurement, motor activity, movement, parental support, physical fitness, public health, screen time

Insufficient physical activity[1,2] and excessive sedentary time, particularly screen time,[3,4] are negatively associated with a variety of physical and mental health indicators in children. Fewer than 10% of Canadian children meet the current guideline of 60 minutes of moderate-to-vigorous physical activity (MVPA) per day.[5]

Parents can influence their children's physical activity through role modeling (being active themselves), material support (financial, logistic, co-participation), and encouragement.[6,7] The degree to which the low level of physical activity in Canadian children is attributable to the family environment is unknown. However, only 15% of Canadian adults meet the current guideline of 150 minutes of MVPA per week,[8] and two studies have reported that Canadian adults with children are less active than those without children.[9,10]

A review of papers that examined links between parents' and children's physical activity yielded mixed results,[6,11,12] partly because of differences in the age groups studied and whether the physical activity was reported or measured. Few studies used accelerometers to investigate relationships between parents' and school-aged (6 to 13) children's physical activity; those that did focused on children in the older end of this age range. Three studies reported a positive association between parents' and children's MVPA,[13-15] while others observed a weak or no association.[16,17] Two analyses of pedometer data reported a positive relationship in steps per day for parents and children.[18,19]

Associations between parents' and children's accelerometer-measured sedentary time also vary,[13,14,16] but parents' and children's reported screen-based behaviours (playing video games, watching television, using a computer) are more consistently associated.[13,16,20,21]

While evidence of the importance of parental role modeling in physical activity is equivocal, evidence of the importance of parental support and encouragement is stronger.[6,11,12,22] Enrolling children in organized sports and activities,[23] paying for and/or providing transportation to activities,[15,24] and encouragement[15,25] are examples of parental factors that have been associated with greater physical activity in children.

This analysis examines associations between measured and reported parent and child physical activity and sedentary behaviour in a sample of 1,328 biological parent-child pairs from the Canadian Health Measures Survey (2007 through 2013). Parental role modeling and support for physical activity, adjusted for household lifestyle habits and socio-demographic characteristics, are considered.

Methods

Data source

The Canadian Health Measures Survey (CHMS) is an ongoing Statistics Canada survey that collects reported and measured health data from the household population aged 3 to 79. Respondents complete a questionnaire in their home and visit a mobile examination centre (MEC) for a series of physical measurements. Residents of Indian Reserves, institutions and certain remote regions, and full-time members of the Canadian

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Forces are excluded. More than 96% of the population is represented. Ethics approval for the CHMS was obtained from Health Canada's Research Ethics Board.[26] Details are available in previous publications.[27-30]

Households are randomly selected at specific data collection sites across Canada. When a household is identified, a member is randomly chosen to participate in the CHMS. If that person is younger than 12, an older member of the same household is also asked to participate. This strategy simplifies survey logistics, as it ensures that young children participating in the CHMS are accompanied to the MEC. As well, it means that data are collected for two members of the same household, in most cases, the same family.

This analysis is based on data from the first three CHMS cycles: 2007 to 2009, 2009 to 2011, and 2012 to 2013. A total of 4,152 children were sampled with another member of their household. Of these, 2,794 were biological parent-child pairs, 1,379 of whom had valid accelerometer data for both the parent and the child. Pregnant women were excluded from the study. Preliminary analyses of the accelerometer data revealed 48 outliers (more than 3 standard deviations from the mean MVPA for parent and child sex). The study examines a sample of 1,328 parent-child pairs in which the children were aged 6 to 11.

Measures

The household interview includes questions about sedentary behaviour. Parents are asked about their child's average time per day: 1) watching TV, videos or playing video games, and 2) on a computer (working, playing games, e-mailing, chatting, surfing the internet). Parents are also asked about their own screen-based activity: average time in a typical week during the past three months 1) on a computer, 2) playing video games, and 3) watching television, DVDs or videos. For this analysis, "screen time" variables were created for children and parents by summing the answers to these questions. For children, the mid-point of the response category selected was used in the summation of screen time (for example, 1.5 hours per day was used if the 1- to 2-hour interval was selected). The response categories for the screen-time questions were changed in cycle 3 from "1 to 2 hours" to "1 to less than 3 hours." The same mid-point (1.5 hours per day) was used for cycle 3.

Body mass index (BMI) was calculated as measured weight in kilograms divided by measured height in metres squared (kg/m^2). Height was measured to the nearest 0.1 centimetre using a ProScale M150 digital stadiometer (Accurate Technology Inc., Fletcher, USA), and weight, to the nearest 0.1 kilogram with a Mettler Toledo VLC with Panther Plus terminal scale (Mettler Toledo Canada, Mississauga, Canada). Parents' BMI was classified as underweight/normal, overweight, or obese based on an international standard using thresholds of 25 (overweight) and 30 (obese) kg/m^2.[31] Children's BMI was classified as thin/normal, overweight, or obese using BMI *z*-scores and thresholds defined by the World Health Organization.[32]

Upon completion of the MEC visit, ambulatory respondents were asked to wear an Actical accelerometer (Phillips – Respironics, Oregon, USA) over their right hip on an elasticized belt during their waking hours for 7 consecutive days. All data were blind to respondents while they wore the device. The Actical measures and records time-stamped acceleration in all directions, providing an index of physical activity intensity via a count and step value for each minute. A valid day was defined as 10 or more hours of wear time. A valid respondent was defined as a minimum of 4 valid days. Wear time was determined by subtracting nonwear time from 24 hours. Nonwear time was defined as at least 60 consecutive minutes of zero counts, with allowance for 1 to 2 minutes of counts between 0 and 100. Published movement intensity thresholds were applied to the data to derive sedentary time and MVPA.[33-35] A complete description of the accelerometer data reduction procedures is available elsewhere.[5,8,28-30,36]

Covariates

Covariates were divided into four groups: parental role modeling, parental support of physical activity, household lifestyle habits, and socio-demographic characteristics.

Parents' physical activity can be regarded as an example for their children (role modeling). Parental role modeling variables were MVPA, step counts, sedentary time, and reported screen time. Associations with those movement variables overall, on weekends, and on weekdays after 3 p.m. were investigated.

The child's participation in lessons or league or team sports was used as a proxy for parental support.[23] It was determined with the question, "About how many hours a week does s/he usually take part in physical activity (that makes him/her out of breath or warmer than usual): ... outside of school while participating in lessons or league or team sports." Response categories were: never, less than 2 hours, 2 to 3 hours, 4 to 6 hours, and 7 or more hours.

Given that lifestyle practices tend to cluster within individuals,[37-39] adjustments for several factors were made in the regression analyses: obesity (child and parent BMI category), child and parent fruit and vegetable consumption (sum of the frequency of daily consumption of 100% fruit juices, fruit, tomatoes or tomato sauce, lettuce or green leafy salad, potatoes, and spinach, mustard greens or collards), smoking status of the parent (daily or occasional smoker versus non-smoker), and child exposure to second-hand smoke.

Socio-demographic characteristics were sex (child and parent), education of parent,[40] lone-parent household, and age of parent.

Table 1
Description of sample, by child and biological parent characteristics, household population, Canada excluding territories, 2007 to 2013

Characteristics	Child				Parent			
	Sample size	Weighted estimate (mean or %)	95% confidence interval		Sample size	Weighted estimate (mean or %)	95% confidence interval	
			from	to			from	to
Sex								
Male	674	53.2	49.6	56.7	558	41.1	37.6	44.7
Female	654	46.8	43.3	50.4	770	58.9	55.3	62.4
Average age (years)	1,328	8.4	8.3	8.6	1,328	39.1	38.5	39.7
Lone-parent household	206	16.2	12.5	20.8	...	...	...	...
Parent's highest level of education								
Secondary school graduation or less	265	20.9	17.4	24.8	...	...	...	...
Postsecondary below bachelor's degree	557	42.8	38.7	47.0	...	...	...	...
Bachelor's degree or more	499	36.3	30.9	42.1	...	...	...	...
Screen time (hours per day)								
Total	1,324	2.3	2.2	2.4	1,327	1.9	1.8	2.1
TV	1,325	1.6	1.5	1.7	1,328	1.1	1.0	1.2
Computer	1,324	0.7	0.7	0.8	1,327	1.3	1.1	1.4
Lessons, league or team sports participation								
Never	375	28.3	24.3	32.7	...	...	...	...
Less than 2 hours per week	283	21.5	18.1	25.5	...	...	...	...
2 to 3 hours per week	407	30.8	26.8	35.1	...	...	...	...
4 to 6 hours per week	185	14.9	11.5	19.0	...	...	...	...
7 or more hours per week	74	4.4[†]	3.1	6.4	...	...	...	...
Fruit and vegetable consumption (times per day)	1,323	4.4	4.3	4.6	1,324	4.3	4.1	4.4
Child exposed to second-hand smoke at home	75	6.6[†]	4.6	9.3	...	...	...	...
Parent is smoker	223	15.5	13.2	18.2	...	...	...	...
Physical activity								
All days								
Sedentary (minutes per day)	1,328	461	454	467	1,328	575	568	583
MVPA (minutes per day)	1,328	60	56	64	1,328	21	19	23
Steps per day	1,328	11,901	11,419	12,383	1,328	8,765	8,384	9,147
Weekends								
Sedentary (minutes per day)	1,264	456	449	462	1,266	559	551	567
Light activity (minutes per day)	1,264	284	277	290	1,266	250	242	259
MVPA (minutes per day)	1,264	48	45	52	1,266	17	15	19
Steps per day	1,264	10,806	10,262	11,350	1,266	8,122	7,711	8,533
Weekdays after 3 p.m.								
Sedentary (minutes per day)	1,328	185	181	189	1,328	225	222	228
Light activity (minutes per day)	1,328	124	121	127	1,328	98	94	102
MVPA (minutes per day)	1,328	26	24	28	1,328	8	7	9
Steps per day	1,328	5,182	4,894	5,470	1,328	3,366	3,183	3,550

... not applicable
[†] use with caution
MVPA = moderate-to-vigorous physical activity
Source: 2007 to 2009, 2009 to 2011, and 2012 to 2013 Canadian Health Measures Survey, combined.

Table 2
Pearson correlation between biological parent and child movement variables and reported screen time, by parent-child pair, household population, Canada excluding territories, 2007 to 2013

Movement variables and reported screen time	Total	Parent-Son	Parent-Daughter
Moderate-to-vigorous physical activity (minutes)			
Average per day	0.21	0.17	0.29
Average per day on weekends	0.17	0.12	0.27
Average per day on weekdays after 3 p.m.	0.24	0.28	0.21
Number of steps			
Average per day	0.19	0.19	0.23
Average per day on weekends	0.26	0.25	0.28
Average per day on weekdays after 3 p.m.	0.21	0.22	0.23
Sedentary time (minutes)			
Average per day	0.19	0.19	0.20
Average per day on weekends	0.11	0.07	0.17
Average per day on weekdays after 3 p.m.	0.12	0.19	0.05
Screen time (hours per day)			
Total	0.10	0.09	0.11
TV	0.10	0.07	0.14
Computer	0.10	0.10	0.11

Source: 2007 to 2009, 2009 to 2011, and 2012 to 2013 Canadian Health Measures Survey, combined.

Statistical analysis

The analyses were weighted with the CHMS combined survey weights generated by Statistics Canada for cycles 1, 2, and 3.[41] Pearson correlations were examined in measured and reported physical activity and sedentary behaviour in parent-son and parent-daughter pairs for specific times: overall, weekends, and weekdays after 3 p.m. Linear regressions were examined, initially adjusting for the sex of the parent and the child, and interaction between the parent's sex and the physical activity variables. Interaction terms were removed because they were not significant in any model. Models were stratified by the child's sex. The final models adjusted for parental role modeling (movement) variables, the parental support variable, household lifestyle, and socio-demographic variables. The data were analyzed using SAS 9.3 (SAS Institute, Cary, NC) and SUDAAN with 35 degrees of freedom. To account for survey design effects, 95% confidence intervals were estimated with the bootstrap technique.[28-30]

Results

The sample of children (n = 1,328) is representative of the Canadian population aged 6 to 11. Their average age was 8, and they accumulated an average of 60 minutes of MVPA a day (Table 1). The parents tended to be mothers (59%), were, on average, 39 years old, and accumulated 21 minutes of daily MVPA (Table 1). The physical activity levels of parents and children in this sample did not differ from those of the complete CHMS sample (data not shown).

Parent-child accelerometer-measured physical activity and sedentary time were correlated (Table 2). For all days, correlations between parent-child MVPA (R = 0.17 to 0.24) and steps (R = 0.19 to 0.26) were similar and exceeded those for sedentary time (R = 0.11 to 0.19). However, these overall results hide differences by the child's sex. Parent-daughter correlations tended to be higher than parent-son correlations, except for MVPA and sedentary time on weekdays after 3 p.m. These differences were driven by the mother-son correlations (R = 0.08 and 0.10 for weekends and overall MVPA correlations, respectively). Relative to the measured data for all days, parent-child correlations were lower for reported screen time and its two components (TV and computer) (Table 2).

Parental role modeling

Overall, a significant association was apparent between parent and child MVPA on all days, on weekends, and on weekdays after 3 p.m. This amounted to an extra 5 to 10 minutes of MVPA for the child if the parent was active for 20 minutes. These associations persisted for girls regardless of the time period, but only on weekdays after 3 p.m. for boys (Table 3).

Steps per day by the parent was also associated with the child's steps for all days, on weekends, and after school (Table 3). The association was significant for boys and girls.

A significant association emerged between parent and child sedentary time overall. As well, the relationship with the parent's reported screen time was significant overall, but not when the child's sex was taken into account (Table 3).

Parental support for physical activity

Reported child participation in at least 2 hours of lessons or league or team sports per week was significantly related to the child's MVPA on all days, after school, and on weekends (Table 4). Parental support for the child's physical activity was also associated with the parent's MVPA overall and on weekends (Figure 1), an association driven mostly by girls (data not shown).

Parental role modeling and support

Parental support for physical activity had an additive effect beyond role modeling on child MVPA (Figure 2). The effect was strongest for the least active parents (less than 10 minutes of MVPA

Table 3
Multivariate regression coefficients relating child movement variables and reported screen time to biological parent movement variables and reported screen time, by sex, household population, Canada, 2007 to 2013

	Both sexes		Boys		Girls	
Movement variables and reported screen time	**Beta**	**p-value**	**Beta**	**p-value**	**Beta**	**p-value**
Moderate-to-vigorous physical activity (minutes)						
Average per day	0.282*	0.0009	0.218	0.1013	0.314*	0.0000
Average per day on weekends	0.290*	0.0001	0.236	0.0500	0.325*	0.0012
Average per day on weekdays after 3 p.m.	0.438*	0.0012	0.535*	0.0191	0.270*	0.0022
Number of steps						
Average per day	0.224*	0.0002	0.239*	0.0140	0.212*	0.0012
Average per day on weekends	0.314*	0.0000	0.332*	0.0000	0.280*	0.0007
Average per day on weekdays after 3 p.m.	0.293*	0.0002	0.350*	0.0009	0.242*	0.0175
Sedentary time (minutes)						
Average per day	0.149*	0.0000	0.137*	0.0070	0.135*	0.0015
Average per day on weekends	0.091	0.0573	0.030	0.6285	0.155*	0.0023
Average per day on weekdays after 3 p.m.	0.121*	0.0011	0.227*	0.0019	0.053	0.3135
Screen time (hours per day)						
Total	0.142*	0.0027	0.113	0.0714	0.148	0.0506
TV	0.188*	0.0004	0.145*	0.0163	0.264*	0.0021
Computer	0.051*	0.0149	0.027	0.3615	0.063*	0.0208

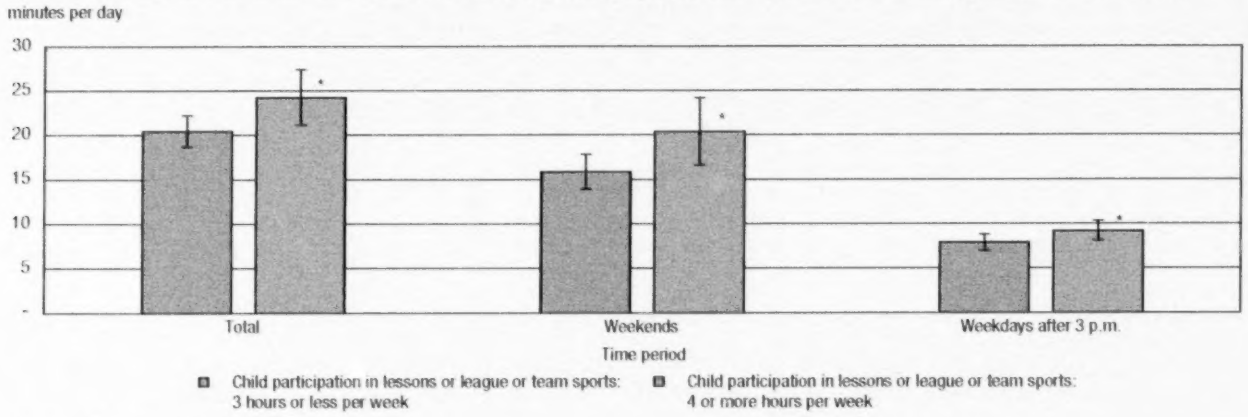
* significantly different from 0 ($p < 0.05$)
Note: In all models, the dependent variable is the child's equivalent movement variable or reported screen time. Models were adjusted for the child's sex (except in sex-stratified models), participation in lessons or league or team sports, body mass index, exposure to second-hand smoke, fruit and vegetable consumption and reported screen time (except in reported screen-time models), and for the parent's age, sex, education, body mass index, smoking status, fruit and vegetable consumption, reported screen time (except in reported screen-time models), lone-parent household, and survey cycle.
Source: 2007 to 2009, 2009 to 2011, and 2012 to 2013 Canadian Health Measures Survey, combined.

per day) and decreased as the parent's activity level increased. For the most active parents (more than 30 minutes of MVPA per day), the additive effect was still positive, but no longer significant.

Household lifestyle and socio-demographic factors

A child's BMI (especially boys') was significantly associated with their MVPA, steps, and sedentary time. Other household lifestyle factors (parent's BMI, parent's and child's fruit and vegetable consumption, second-hand smoke exposure, parent's smoking status) were not associated with the child's physical

Figure 1
Biological parent average daily minutes of moderate-to-vigorous physical activity (MVPA), by time period and by child participation in lessons or league or team sports, household population, Canada excluding territories, 2007 to 2013



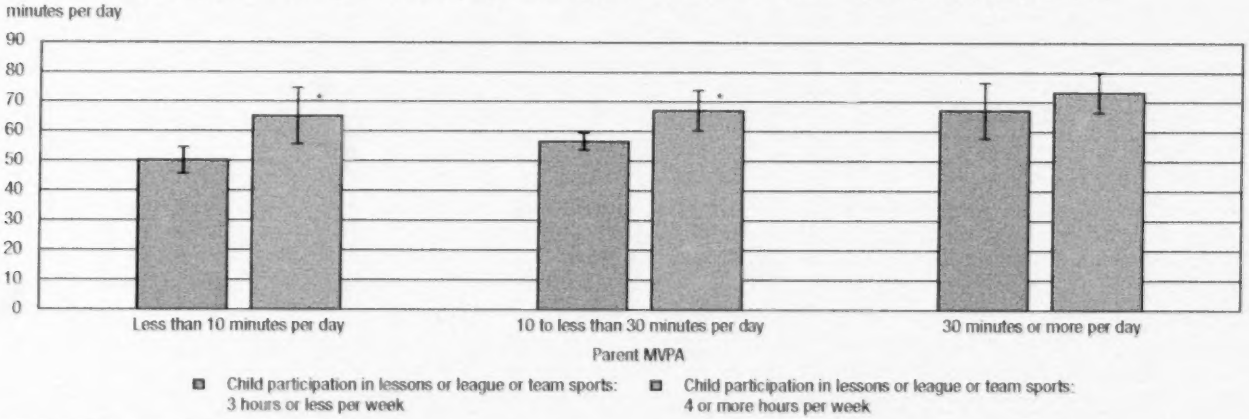
* significantly different from 3 hours or less per week ($p < 0.05$)
I = 95% confidence interval
Source: 2007 to 2009, 2009 to 2011, and 2012 to 2013 Canadian Health Measures Survey, combined.

Table 4
Multivariate regression coefficients relating child moderate-to-vigorous physical activity (MVPA) to participation in lessons or league or team sports, by sex, household population aged 6 to 11, Canada, 2007 to 2013

	Both sexes		Boys		Girls	
MVPA models and participation in lessons or league or team sports	**Beta**	**p-value**	**Beta**	**p-value**	**Beta**	**p-value**
Average MVPA per day model						
Participation in lessons or league or team sports						
Never[†]	...	...	...	...	...	...
Less than 2 hours per week	0.2	0.943	-1.1	0.780	1.4	0.621
2 to 3 hours per week	5.9*	0.006	7.6*	0.023	4.2	0.094
4 to 6 hours per week	12.4*	0.000	14.0*	0.006	10.6*	0.000
7 or more hours per week	10.6*	0.001	8.1	0.168	13.0*	0.000
Average MVPA per day on weekends model						
Participation in lessons or league or team sports						
Never[†]	...	...	...	...	...	...
Less than 2 hours per week	0.7	0.852	1.1	0.854	1.4	0.759
2 to 3 hours per week	6.2*	0.040	7.2*	0.046	5.7	0.200
4 to 6 hours per week	11.3*	0.007	14.6*	0.025	10.3*	0.016
7 or more hours per week	10.6*	0.022	2.5	0.733	18.1*	0.001
Average MVPA per day on weekdays after 3 p.m. model						
Participation in lessons or league or team sports						
Never[†]	...	...	...	...	...	...
Less than 2 hours per week	1.6	0.320	0.9	0.760	2.0	0.227
2 to 3 hours per week	5.1*	0.002	7.1*	0.009	2.3	0.160
4 to 6 hours per week	8.4*	0.000	8.0*	0.023	9.3*	0.001
7 or more hours per week	10.1*	0.000	7.6	0.068	12.6*	0.000

... not applicable
* significantly different from reference category ($p < 0.05$)
† reference category
Note: Models were adjusted for the child's sex (except in sex-stratified models), body mass index, exposure to second-hand smoke, fruit and vegetable consumption and reported screen time (except in reported screen-time models), and for the parent's age, sex, movement variable, education, body mass index, smoking status, fruit and vegetable consumption, reported screen time (except in reported screen-time models), lone-parent household, and survey cycle.
Source: 2007 to 2009, 2009 to 2011, and 2012 to 2013 Canadian Health Measures Survey, combined.

Figure 2
Child average daily minutes of moderate-to-vigorous physical activity (MVPA), by participation in lessons or league or team sports and biological parent MVPA, household population aged 6 to 11, Canada excluding territories, 2007 to 2013



* significantly different from 3 hours or less per week ($p < 0.05$)
I = 95% confidence interval
Source: 2007 to 2009, 2009 to 2011, and 2012 to 2013 Canadian Health Measures Survey, combined.

activity (data not shown). As well, the socio-demographic characteristics were generally not significant—the only associations were with lone-parent household status in the steps-per-day model, and with the parent's education in the sedentary time model (data not shown).

Discussion

This analysis shows that parental role modeling and support for physical activity were independently associated with the physical activity of a representative sample of Canadian children aged 6 to 11. The effect amounted to an increase of 5 to 10 minutes in a child's MVPA for every additional 20 minutes of the parent's MVPA. Regardless of parents' physical activity, supporting children through enrolment in lessons or league or team sports led to further increases in children's physical activity. Whether the parent was a mother or father did not affect the associations; however, differences were apparent between parent-daughter and parent-son pairs.

Overall, parents' MVPA was positively correlated with the MVPA of their sons and daughters. A lack of correlation was observed between mothers and sons, a finding also reported by Fuemmeler et al.[14]

While the significant association in parent-child MVPA in the CHMS analysis confirm previous research,[13-15] comparisons of studies are limited by differences in child age, in the availability of data for one or both parents, and in how the accelerometer data were reduced and analyzed. As well, in the studies reporting a significant association between parent and child MVPA in adjusted regression models,[13-15] including the present analysis, the effect was relatively narrow, with Beta values ranging from 0.23 to 0.44.

Two earlier studies that did not report a significant association between measured parent and child MVPA[16,17] noted sample biases that may explain the lack of agreement; specifically, the data were not representative of a wide range of socioeconomic groups, and the parents were predominantly mothers (more than 80%).

The CHMS analysis found that for every 1,000 steps that a parent accumulated per day, the child accumulated 200 to 350 additional steps. This is similar to a Canadian study that used pedometers and found that 1,000 steps per day by a parent equated to 195 to 439 steps per day by their child.[18]

According to the CHMS results, parents' and children's measured sedentary time were related, but the magnitude was low—each additional hour of a parent's sedentary time was associated with an 8- to 15-minute increase in the child's sedentary time. Other research, too, has found either no association or weak associations between parents and children in measured sedentary time.[13,14,16]

Reported screen time tends to be more consistently associated between parents and children,[13,16,20,21] but in the present study, an association emerged only for parent-daughter pairs. Differences in the presence and strength of associations between measured and reported sedentary behaviour have been noted in relation to health outcomes[42] and may result from the low inter-individual variability in measured sedentary time.[43]

Parental support and encouragement are associated with children's physical activity.[9,11,12,22-25] However, the only relevant variable in the CHMS is the number of hours a week a child participates in lessons or league or team sports, for which it is assumed that parents make arrangements.[23] Child participation in lessons or league or team sports was associated with increased physical activity not only in the child, but also in the parent. It is not known if this indicates parental involvement in the activity itself (coach, referee, volunteer), but the likelihood of co-participation in physical activity has been shown to increase when children are involved in organized sports and activities.[44] Although the CHMS analysis did not examine parent and child MVPA levels at the same time, the data pertained to periods when children were more likely

What is already known on this subject?

- Insufficient physical activity and excessive sedentary time are negatively associated with a range of physical and mental health indicators in children.
- Parents influence their children's physical activity through role modeling (being active themselves), material support (financial, logistic, co-participation), and encouragement.
- Fewer than 10% of Canadian children meet the current guideline of 60 minutes of moderate-to-vigorous physical activity per day, and only 15% of Canadian adults meet the current guideline of 150 minutes of moderate-to-vigorous physical activity per week.
- Research on associations between parents' and children's physical activity and sedentary time yields mixed results; evidence of the importance of parental support and encouragement is more consistently positive.

What does this study add?

- Associations between accelerometer-measured and reported parents' and children's physical activity and sedentary behaviour were examined in a sample of 1,328 biological parent-child pairs from the 2007 to 2013 Canadian Health Measures Survey.
- Parents' measured moderate-to-vigorous physical activity was associated with that of their children.
- Parents' measured sedentary time was associated with that of their daughters on weekends, and with that of their sons during the after-school period.
- Parents' reported screen time was associated only with that of their daughters.
- Parental role modeling and support had independent effects on children's physical activity.

to be with their parents (after school, evenings, weekends).

Tate et al. reported that inactive parents could overcome their lack of role modeling through effective encouragement, but for active parents, encouragement did not further augment their children's already-high levels of physical activity.[15] Although the analytical approach and definition of support/encouragement in the CHMS analysis differed from that of Tate et al., the present study demonstrated that support has an additive and positive effect, regardless of the parents' level of MVPA. The findings of Tate et al. suggest that parental role modeling and support/encouragement may be interchangeable, whereas in the present study, parental role modeling and support had independent effects on children's physical activity.

The sex of the parent was not significant in the CHMS analysis, which is consistent with some previous research.[15,17,18,45] Others have reported a stronger effect of mothers' physical activity on that of their children.[19,22,23] The explanation relates to mothers' spending more time with their children compared with fathers and having more responsibility for providing logistic support for participation in activities.

Strengths and limitations

Among the strengths of this analysis is the large sample of biological parent-child pairs for whom accelerometer-measured physical activity data were collected. As well, the study is representative of Canadian children aged 6 to 11, uses validated cut-points for MVPA and sedentary time, and focuses on specific times when parents and children are likely to be together. Models were adjusted for several potential confounders, including household lifestyle and standard socioeconomic variables.

Nonetheless, the study has some limitations. Accelerometers are limited in the measurement of water-based activities, cycling and load-carrying, and so may underestimate MVPA for both parents and children. The overall survey response rate was low, and the study sample size was further reduced by including only biological parent-child pairs. Although previous research has shown that children are more active when both parents are active,[14] this could not be investigated because data were available for only one parent. Household lifestyle characteristics cluster in children,[38,39] but the variables selected (for example, fruit and vegetable consumption, exposure to second-hand smoke) were not significant in any of the models. These variables were meant to represent the general value a household places on healthy living, but they may be too far removed from physical activity patterns. Participation in lessons or league or team sports is an approximation of parental support that was meant to represent facilitation (transportation, paying for equipment and materials). Although this measure has been used before,[23] interpretation is limited by the nature of the question.

Conclusion

In a representative sample of Canadian children, parental role modeling and support for physical activity were independently associated with children's level of physical activity. Examining key parental influences on children's physical activity may support the development of family-based health interventions and guidelines.

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References

1. Janssen I, LeBlanc AG. Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *International Journal of Behavioral Nutrition and Physical Activity* 2010; 7: 40.
2. Poitras VJ, Gray CE, Borghese MM, et al. Systematic review of relationships between objectively measured physical activity and health indicators in school-aged children and youth. *Applied Physiology, Nutrition, and Metabolism* 2016; 43(6 Suppl 3): S197-239.
3. Leblanc AG, Spence JC, Carson V, et al. Systematic review of sedentary behaviour and health indicators in the early years (age 0-4 years). *Applied Physiology, Nutrition, and Metabolism* 2012; 37: 345-69.
4. Carson V, Hunter S, Kuzik N, et al. Systematic review of sedentary behaviour and health indicators in school-aged children and youth: an update. *Applied Physiology, Nutrition, and Metabolism* 2016; 43(6 Suppl 3): S240-65.
5. Colley RC, Garriguet D, Janssen I, et al. Physical activity of Canadian children and youth: Accelerometer results from the 2007 to 2009 Canadian Health Measures Survey. *Health Reports* 2011; 22(1): 15-23.
6. Gustafson SL, Rhodes RE. Parental correlates of physical activity in children and early adolescents. *Sports Medicine* 2006; 36(1): 79-97.
7. Bauman AE, Reis RS, Sallis JF, et al. Correlates of physical activity: why are some people physically active and others not? *Lancet* 2012; 380: 258-71.
8. Colley RC, Garriguet D, Janssen I, et al. Physical activity of Canadian adults: Accelerometer results from the 2007 to 2009 Canadian Health Measures Survey. *Health Reports* 2011; 22(1): 1-14.
9. Adamo KB, Langlois KA, Brett KE, Colley RC. Young children and parental physical activity levels: findings from the Canadian Health Measures Survey. *American Journal of Preventive Medicine* 2012; 43(2): 168-75.

10. Gaston A, Edwards SA, Doelman A, Tober JA. The impact of parenthood on Canadians' objectively measured physical activity: an examination of cross-sectional population-based data. *BMC Public Health* 2014; 14: 1127.

11. Van Der Horst K, Chin A. Paw MJ, et al. A brief review on correlates of physical activity and sedentariness in youth. *Medicine and Science in Sports and Exercise* 2007; 39(8): 1241-50.

12. Xu H, Ming Wen L, Rissel C. Associations of parental influences with physical activity and screen time among young children: A systematic review. *Journal of Obesity* 2015; 2015: 546925. doi 0.1155/2015/546925

13. Tu AW, Watts AW, Mâsse LC. Parent-Adolescent patterns of physical activity, sedentary behaviors and sleep among a sample of overweight and obese adolescents. *Journal of Physical Activity and Health* 2015; 12: 1469-76.

14. Fuemmeler BF, Anderson CB, Mâsse LC. Parent-child relationship of directly measured physical activity. *International Journal of Behavioral Nutrition and Physical Activity* 2011; 8: 17.

15. Tate EB, Shah A, Jones M, et al. Toward a better understanding of the link between parent and child physical activity levels: The moderating role of parental encouragement. *Journal of Physical Activity and Health* 2015; 12: 1238–44.

16. Jago R, Fox KR, Page AS, et al. Parent and child physical activity and sedentary time: Do active parents foster active children? *BMC Public Health* 2010; 10: 194.

17. Jago R, Sebire SJ, Wood L, et al. Associations between objectively assessed child and parental physical activity : a cross-sectional study of families with 5-6 year old children. *BMC Public Health* 2014; 14: 655.

18. Craig CL, Cameron C, Tudor-Locke C. Relationship between parent and child pedometer-determined physical activity: a sub-study of the CANPLAY surveillance study. *International Journal of Behavioral Nutrition and Physical Activity* 2013; 10: 8.

19. Sigmund E, Sigmundová D, Bad'ura P, Vorácová J. Relationship between Czech parent and child pedometer-assessed weekday and weekend physical activity and screen time. *Central European Journal of Public Health* 2015; 23: S83-90.

20. Salmon J, Timperio A, Telford A, et al. Association of family environment with children's television viewing and with low level of physical activity. *Obesity Research* 2005; 13(11): 1939-51.

21. Jago R, Stamatakis E, Gama A, et al. Parent and child screen-viewing time and home media environment. *American Journal of Preventive Medicine* 2012; 43(2): 150-8.

22. Verloigne M, Van Lippevelde W, Maes L, et al. Family- and school-based correlates of energy balance-related behaviours in 10-12-year-old children: a systematic review within the ENERGY (EuropeaN Energy balance Research to prevent excessive weight Gain among Youth) project. *Public Health Nutrition* 2012; 15(8): 1380-95.

23. Erkelenz N, Kobel S, Kettner S, et al. Parental activity as influence on children's BMI percentiles and physical activity. *Journal of Sports Science and Medicine* 2014; 13: 645-50.

24. Hennessy E, Hughes SO, Goldberg JP, et al. Parent-child interactions and objectively measured child physical activity: a cross-sectional study. *International Journal of Behavioral Nutrition and Physical Activity* 2010; 7: 71.

25. Ferrao T, Janssen I. Parental encouragement is positively associated with outdoor active play outside of school hours among 7-12 year olds. *PeerJ* 2015; 3: e1463.

26. Day B, Langlois R, Tremblay MS, Knoppers B-M. Canadian Health Measures Survey: Ethical, legal and social issues. *Health Reports* 2007; 18 (Suppl): 37-51.

27. Tremblay MS, Wolfson M, Connor Gorber S. Canadian Health Measures Survey: Background, rationale and overview. *Health Reports* 2007; 18(Suppl): 7-20.

28. Statistics Canada. *Canadian Health Measures Survey (CHMS) Data User Guide: Cycle 1 April 2011*. Available at: http://www23.statcan.gc.ca/imdb-bmdi/document/5071_D2_T1_V1-eng.pdf

29. Statistics Canada. *Canadian Health Measures Survey (CHMS) Data User Guide: Cycle 2 November 2012*. Available at: http://www23.statcan.gc.ca/imdb-bmdi/document/5071_D4_T9_V1-eng.htm

30. Statistics Canada. *Canadian Health Measures Survey (CHMS) Data User Guide: Cycle 3 November 2014*. Available at: http://www23.statcan.gc.ca/imdb-bmdi/document/5071_D6_T9_V1-eng.htm

31. World Health Organization. *Obesity: Preventing and Managing the Global Epidemic* (WHO Technical Report Series, No. 894) Geneva: World Health Organization, 2000.

32. de Onis M, Onyango AW, Borghi E, et al. Development of a WHO growth reference for school-aged children and adolescents. *Bulletin of the World Health Organization* 2007; 85(9): 660-7.

33. Colley RC, Tremblay MS. Moderate and vigorous physical activity intensity cut-points for the Actical accelerometer. *Journal of Sports Science* 2011; 29(8): 783-9.

34. Puyau MR, Adolph AL, Vohra FA, et al. Prediction of activity energy expenditure using accelerometers in children. *Medicine and Science in Sports and Exercise* 2004; 36: 1625-31.

35. Wong S, Colley RC, Connor Gorber S, Tremblay MS. Actical accelerometer sedentary activity thresholds for adults. *Journal of Physical Activity and Health* 2011; 8: 587-91.

36. Colley RC, Connor Gorber SC, Tremblay MS. Quality control and data reduction procedures for accelerometry-derived measures of physical activity. *Health Reports* 2010; 21(1): 63-9.

37. Adams ML, Katz DL, Shenson D. A healthy lifestyle composite measure: Significance and potential uses. *Preventive Medicine* 2016; 84: 41-7

38. Gubbels JS, Kremers SPJ, Stafleu A, et al. Clustering of energy balance-related behaviors in 5-year-old children: Lifestyle patterns and their longitudinal association with weight status development in early childhood. *International Journal of Behavioral Nutrition and Physical Activity* 2012; 9: 77.

39. Cameron AJ, Crawford DA, Salmon J, et al. Clustering of obesity-related risk behaviors in children and their mothers. *Annals of Epidemiology* 2011; 21: 95-102.

40. Bushnik T, Garriguet D, Colley RC. Parent-Child association in body weight status. *Health Reports* 2017; 28(6): 9-16.

41. Statistics Canada. Instructions for Combining Multiple Cycles of Canadian Health Measures Survey (CHMS) Data November 2014. Available at: http://www23.statcan.gc.ca/imdb-bmdi/document/5071_D6_T9_V1-eng.htm

42. Carson V, Janssen I. Volume, patterns, and types of sedentary behavior and cardio-metabolic health in children and adolescents: a cross-sectional study. *BMC Public Health* 2011; 11: 274.

43. Colley RC, Wong SL, Garriguet D, et al. Physical activity, sedentary behaviour and sleep in Canadian children: Parent-report versus direct measures and relative associations with health risk. *Health Reports* 2012; 23(2): 45-52.

44. Lee SM, Nihiser A, Strouse D, et al. Correlates of children and parents being physically active together. *Journal of Physical Activity and Health* 2010; 7: 776-83.

45. Schoeppe S, Liersch S, Robl M, et al. Mothers and fathers both matter: The positive influence of parental physical activity modelling on children's leisure-time physical activity. *Pediatric Exercise Science* 2016; epub ahead of print.